

# Intelligent Analyzing Module in the Academic Staff Performance Appraisal System

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## Abstract

In the scientific work, a module is proposed that allows to detect incorrect and irrelevant information based on the content analysis of web resources in the intellectualized academic staff performance appraisal system. The methods and means of detecting irrelevant information based on existing user needs are analyzed. This module allows to analyze the information filled in by the user and make an automatic analysis of its correctness.

## Keywords <sup>1</sup>

Web system, performance appraisal system, academic staff, scientific and pedagogical workers, rating, correctness of information, higher education institution.

## 1. Introduction

Improving the work of scientific and pedagogical workers is important for a higher education institution. This will allow: to improve the educational process (if scientific workers work efficiently, the educational process becomes more qualitative, which leads to better training of students and an increase in the university's rating); attract funding (additional funds are attracted to educational institutions that have highly qualified scientific workers); increase competitiveness (universities constantly compete with each other for students, funding and other resources, accordingly, qualified employees increase their competitiveness, which increases the number of students and the attractiveness of the university for employers); career development of employees (conducting scientific and research work and publishing scientific articles contributes to the professional development and career development of employees) [1].

To improve the work of scientific and pedagogical workers, a number of measures can be taken, for example:

- organization of education and trainings that will help improve their professional skills and knowledge;
- involvement in scientific and research work, which contributes to the development of science and increasing the rating of the university;
- academic staff support and motivation (financial support, prizes and awards);
- introduction of new technologies into the educational process [2].

The evaluation of the effectiveness of the academic staff activities can be carried out on the basis of various criteria, depending on the specific situation and requirements of the university, for example:

- the educational process (assessment of the quality of learning, degree of education for classes);
- scientific work (assessment of the level of research work, number of publications, participation in scientific conferences, projects);
- organizational activity (assessment of participation in the work of university management bodies, performance of tasks assigned to the employee, organization of conferences, seminars);

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- cooperation with other scientists and universities (level of cooperation with colleagues, involvement in joint projects, cooperation with other universities).

It is important to take into account that the evaluation should be objective and based on criteria that were established in advance. In addition, it should be remembered that the evaluation should not be the only criterion for determining the effectiveness of the work of a scientific and pedagogical worker [3], [4].

The most popular method of evaluating the performance of employees in many universities is rating systems [5].

## 2. Formulation of the Problem

In many universities, the rating system includes the opportunity for employees to independently contribute their achievements. For example, a scientific worker can add his publications in scientific journals, feedback from students, participation in projects, conferences, seminars and other information about his activities. These informative materials can be included in his personal profile in the rating system. However, it is important that the information provided by the employee is objective and supported by relevant documents. Also, it is important to consider that the rating system should be comprehensive and evaluate the employee's work according to various aspects of the activity, and not only based on what the employee independently enters into the system.

Verification of the correctness of the information provided by the employee is very important, as it helps to ensure the objectivity of the evaluation of his work. In addition, inaccurate information can lead to incorrect conclusions about the employee's performance, which can negatively affect his career and reputation, and cause the expenditure of time and resources to verify and correct data. Therefore, checking the information for correctness is necessary to ensure the accuracy and objectivity of the rating system and to ensure a fair assessment of the employee's work.

Currently, not all universities in Ukraine have their own academic staff performance appraisal system, but some of them already do so. Here are some examples of universities that have their own systems: National University "Kyiv-Mohyla Academy", National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute", Taras Shevchenko Kyiv National University, Ivan Franko Lviv National University, Odesa National University named after I. I. Mechnikov, West Ukrainian National University (WUNU), and others.

If we compare different rating systems, they provide a variety of functions, among which we can highlight: evaluation of academic staff activities according to various parameters (such as learning quality, scientific activity, professional development, etc.); stimulating to improve the activities (through ratings); determination of priority areas of development (analysis of the results of ratings and statistics allows to determine the priority areas of development of academic staff and their weak areas); monitoring the quality of education and making the necessary adjustments; stimulating the academic staff to professional development and continuous improvement of their work; show the rating of a specific users (users can view the rating of academic staff at the university according to various criteria); provide performance reports (number of publications in scientific journals, number of citations, etc.).

An important function for such systems is the verification of user documents, namely the process of checking the correctness of the data entered by the employee. The rating system used by WUNU [5] has certain means of verifying the data entered by the user, these are: software validation of the data (for example, implemented automatic checks for compliance with certain formats, checks for spelling, grammar and other optional standards to help avoid errors and ensure the correctness of entered data); review (this is the process of evaluating and analyzing the work of a certain employee, and it includes the review of scientific studies, articles, books, dissertations, abstracts and other types of activities, where it is important to make a critical analysis of the information presented and express an opinion about its reliability). But peer review is practically a manual data processing process that takes a lot of human resources and time that could be used more effectively. Therefore, the creation of a module for automatic validation of user data, which would be integrated into an intellectualized academic staff performance appraisal system, is an important task.

### 3. Designing a software module

#### 3.1. Architecture

Considering the architecture of the rating system at WUNU, it was decided to use a client-server architecture. It is the most common and is based on the separation of functionality between the client and the server, and allows creating software systems with distributed data:

- provides fast and reliable data exchange between the client and the server,
- allows the use of different programming languages and technologies,
- provides a convenient user interface and high performance,
- security and availability of the system.

Accordingly, there is no binding to a specific programming language or DBMS. The database in the specified system is implemented using MySQL - the most famous open relational DBMS, which is used in most large organizations for data storage and management. The Laravel framework was used to write the module. It is used to develop web applications and APIs in the PHP programming language (which will need to write a data validation module), supports MVC (an architectural pattern for software design), and has a large number of components and libraries that allow to extend its functionality and support the best development practices. Controllers are responsible for processing requests from users and calling the appropriate methods and models to retrieve and store data. View files are responsible for displaying data on the client side and interacting with the user. MVC in Laravel allows to divide the logic of the application into components and make the code more clean and organized [6-7].

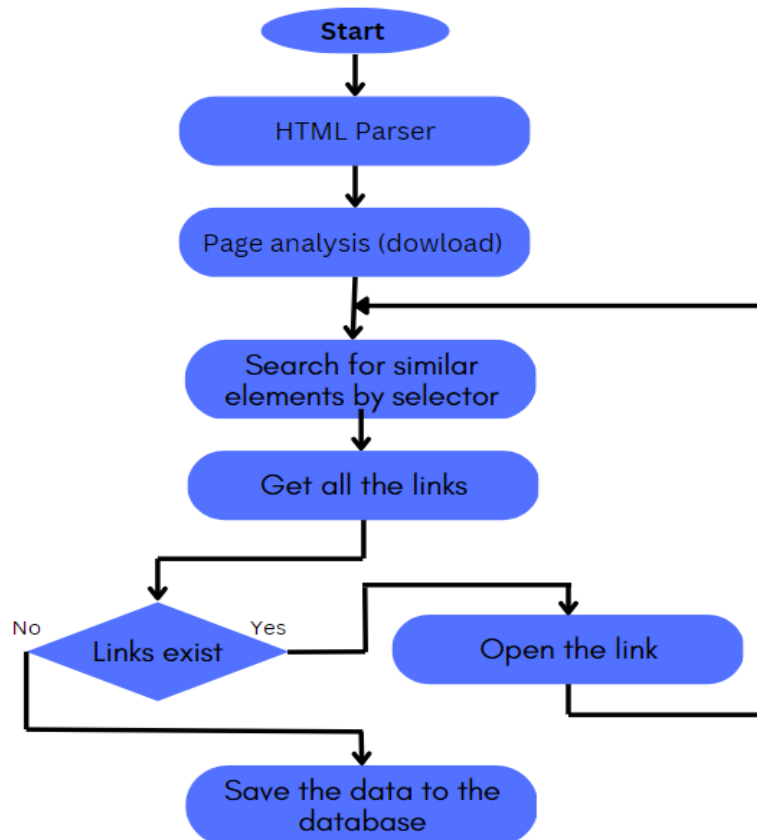
In the WUNU rating system, users can fill out annual reports on their scientific activities. The report is populated using various criteria, which are created by the system administrators in accordance with the annual rating regulation. Some criteria allow users to enter data about their articles, publications, research papers, and more.

#### 3.2. Data collection for module operation

First, it need to collect data and carry out their initial verification [8-9]. When users need to enter a link to a certain resource (a specific file or a link to a web format for viewing articles\publications), a semantic analysis of this code (the resource to which the user refers) is performed, and the results are stored in the database. Most web pages are created using HTML or XHTML. HTML allows to embed a variety of elements on a page, such as images, videos, forms, tables, lists, links, and more. In addition, HTML can be used to describe the structure of a page and make it accessible to search engines and other web analysis tools. Accordingly, all websites have the same HTML markup, which makes it possible to reproduce the document using a browser in a form familiar to the user. The main content of the pages is contained in the <body> tag, but the tags can have different names and sequences, which can make them difficult to parse.

Understanding how the resource page is built, now it is necessary to perform parsing of sites (web pages), that is, sequential syntactic analysis of information. Web pages themselves may have a hierarchical data set structured in some format.

Web parsing is used to automatically collect data from web pages is an important step. This process includes parsing the HTML code of a web page. We get the main context and main attributes (headers, titles, <body>, <label>, <context>, eth) of the page using HTML parsing and MeaningCloud Text Analytics Api). Then we extracting the necessary information and saving it in a convenient format (CSV) for later use, for example, in a database [10]. We store the main category tags in the database in order to be able to compare the data entered by the user in the future, and to have a history of changes. If there are other links in the context of the user resource (which have similar keywords in the "header"), we will check them in the same way as the current resource. In the future, it will be necessary to formulate basic requirements for algorithms for automated detection of outdated and unreliable information. A simplified diagram of gathering information using parsing and saving information (Figure 1).



**Figure 1:** A simplified scheme for gathering information using parsing

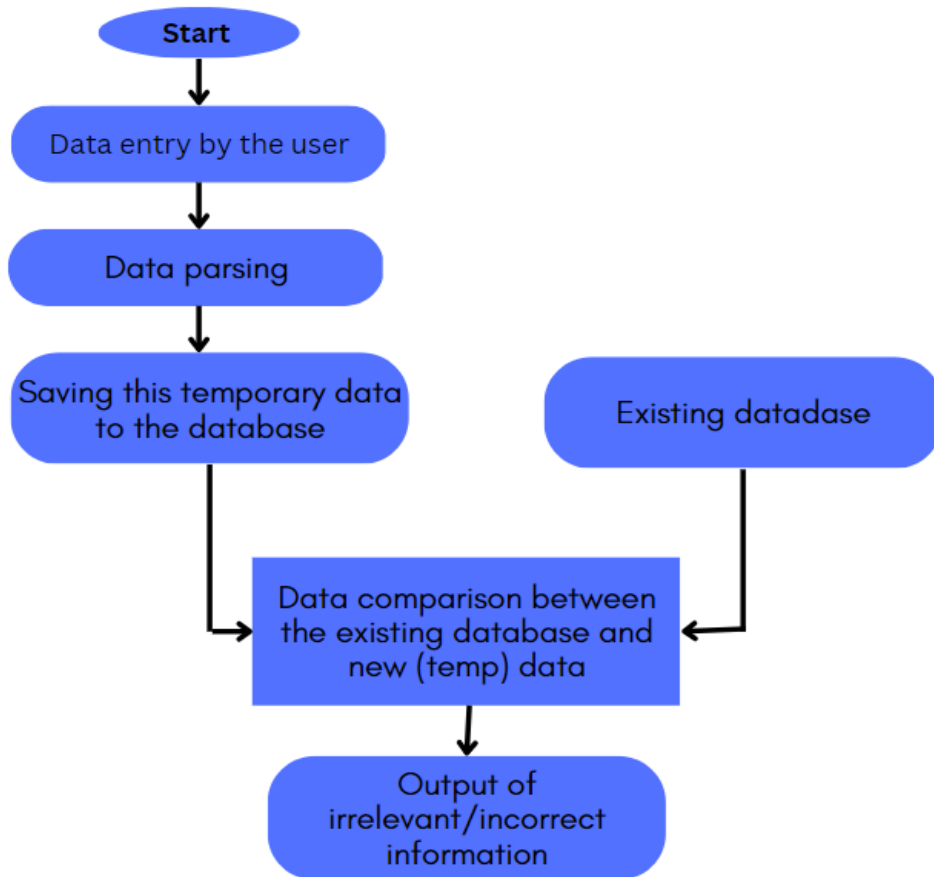
### 3.3. Process of selecting incorrect information

In order to display the received data in the correct form, it is necessary to process them and highlight the main information, which will be enough to save short tags on request. For this, the CSV format was used to save intermediate and final data. It is easily opened through Excel, and easily converted into SQL queries for further work. Collected digital data may be analyzed using mathematical models [11] for predicting some values.

A more complex process is identifying incorrect and outdated information based on content analysis of web resources. In the WUNU rating system, each user has a certain set of tags that associate and verify him. These can be mandatory tags (which the user must fill in on their own), general tags (which the user can fill in at will), optional external tags (which are entered by their heads of departments, or senior academic staff of the university), and specific tags for each answer (entered data) of the user in the report (entered by the user). Having a complete database (a certain set of correct data/tags) about the user, a method of detecting incorrect and outdated information on web resources was implemented by comparing it with its own database.

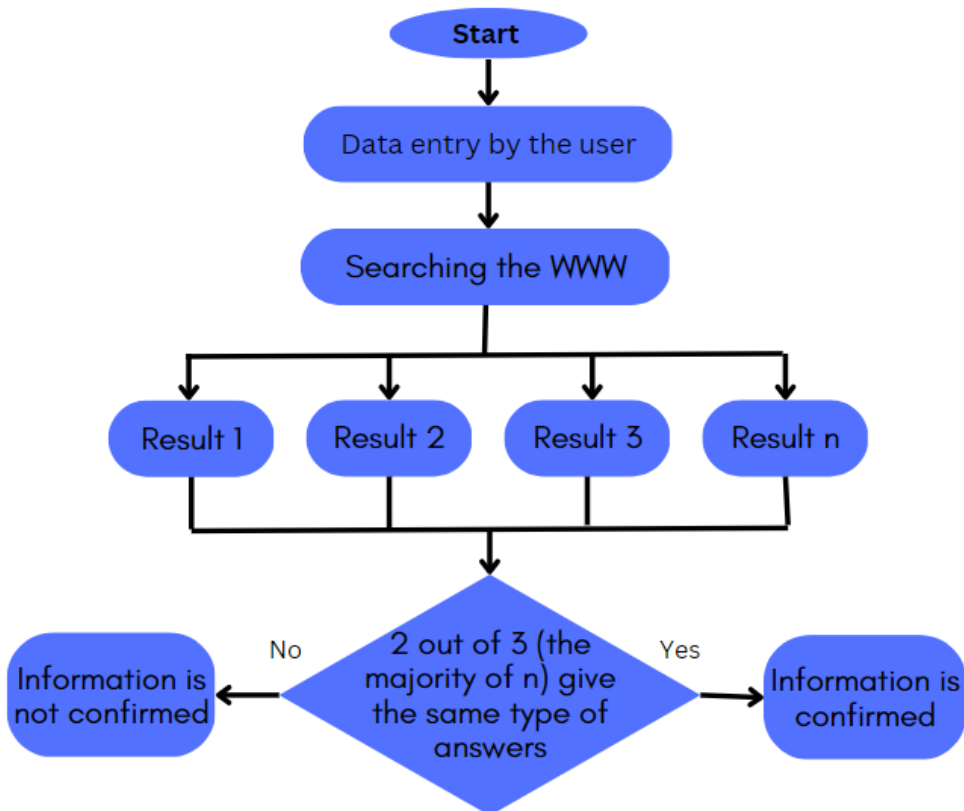
The schematic structure of the process of preparation for the procedure of identifying irrelevant and unreliable information on web resources is shown in (Figure 2), and involves the following actions:

- collecting content/information, most often by downloading a web page and processing it.
- the received data in HTML format is transformed into the specified format.
- conversion of the obtained results into a higher format convenient for users and employees and saving in a database.
- comparison of received data with existing data in the database and evaluation of information.



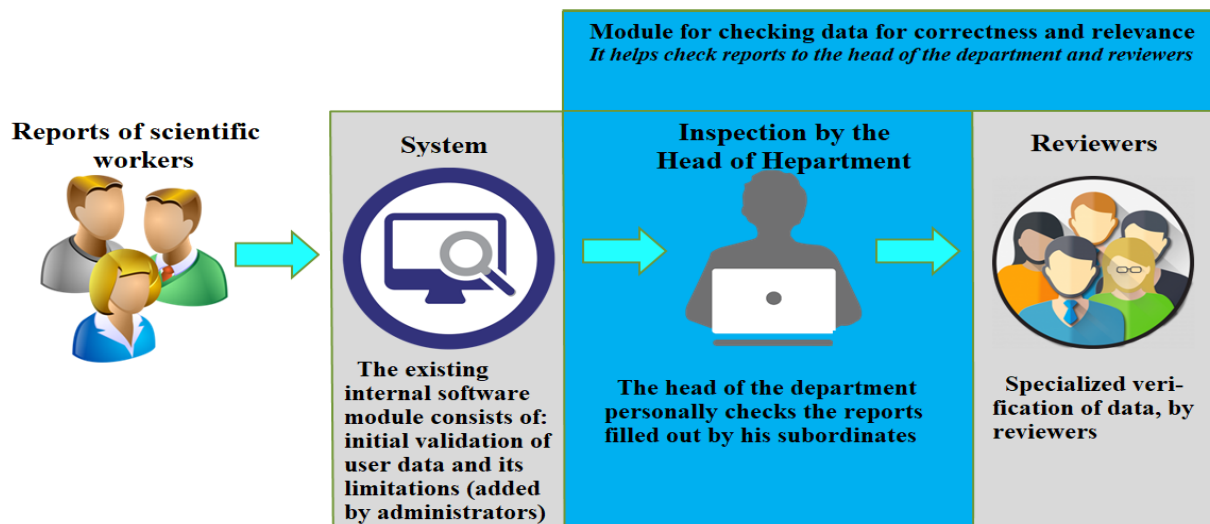
**Figure 2:** Scheme of output of incorrect or irrelevant information in comparison with the existing database

It may also be the case that the existing database is not filled, or there is no information on a specific user (for comparison), so it is necessary to analyze the information based on the content of external web resources. One way to check the data is to check other sources that can confirm the input information. This can help determine how reliable and correct the information received is. And for this, search web browsers are used, which make it possible to search for various types of content on the Internet (for example, web pages). Search web browsers are powered by various search algorithms that typically use keywords or phrases to find relevant content. In addition, they use other methods, such as ranking results by relevance, analyzing context, and using other metrics to provide quality search results to users. This way of searching for data can yield a certain number of web resources (which may contain content similar to the content analyzed by the informational web resource). If there are multiple sources of data (pages) that are obtained as a result of the search web browsers and they provide information about whether a particular entry is correct or not, a majority vote method can be applied to determine which information is correct. To do this, it need to compare the results of each data source and determine which value occurs most often. If more than half of the sources confirm the authenticity of the entry, then it can be assumed that this value is correct. It can use the majority method, that is, the majority of search results must confirm the information in order to recognize it as valid. The implementation scheme of the "majority voting" method with the received n-results of web resources is shown on (Figure 3).



**Figure 3:** Implementation scheme of the "majority voting" method

After the implementation of this module for detecting incorrect and outdated user information, the general structure of the process of checking and approving the report will look like this (Fig. 4).



**Figure 4:** Report approval process with new data validation module

#### 4. Conclusion

In this work, a module for detecting incorrect and irrelevant information based on content analysis of web resources is proposed for an intellectualized academic staff performance appraisal system. Validation of data entered by academic staff is important to ensure the accuracy and reliability of data

used to make decisions in the field of management of a higher education institution. For example, if the data on a academic staff's scientific publications or his academic achievements are not reliable, this may lead to incorrect determination of his rating, incorrect distribution of financial resources, as well as incorrect decision-making regarding his career development.

In addition, data validation is an important element of data quality control and protection against possible errors or carelessness in their entry. This can help prevent inaccurate, false, or incomplete information from being entered, which could spoil the results of data analysis and lead to negative consequences for the university and its employees.

The novelty of the work consists in the integration of the module for checking the correctness and conformity of the data entered by the user (answers to certain criteria) into the existing system of rating users of the university, taking into account the features of this rating system (the form of filling out the report, the format of the answers, the user's sphere of activity).

This module is being prepared for integration into the WUNU rating system. Currently, the module is at the final stage of implementation. Testing took place on a local machine with personal test data. A part of the data of the production base, for the previous rating year, is being prepared, and now criteria and tags are added to the necessary entities so that the module can be tested on real data. For the university, this new module is an improvement of the current rating system, which expands its work and the functionality of the system. Therefore, this module will improve the rating system of the university, automate part of the process of checking user reports and simplify the work of department heads and reviewers, accordingly, not only the efficiency of the employees will increase, but also the efficiency of the activity and the image of the university.

## 5. References

- [1] N. Morse and O. Buynytska, "System of rating indicators for evaluating the performance of teachers of modern universities", *Scientific journal of the NPU named after M.P. Drahomanova. Series 2. Computer-oriented learning systems*, 2019, pp. 34–44.
- [2] T. Loukkola, H. Peterbauer, A. Gover, "Exploring higher education indicators", May 2020, p. 15.
- [3] A. Gover, T. Loukkola and H. Peterbauer, "Student-centred learning: approaches to quality assurance", September 2019, p. 12.
- [4] M. Gaebel, T. Zhang, L. Bunesu and H. Stoeber, "Trends Learning and Teaching in the European Higher Education Area", 2018, p. 70.
- [5] A. Pukas, A. Simak, S. Shandruk, L. Bilovus, V. Stepanenko and A. Demianiuk, "Features of Implementation the Academic Staff Performance Appraisal System", 2022 12th International Conference on Advanced Computer Information Technologies, Proceedings of the 11th International Conference, ACIT 2022, Ruzomberok, Slovakia, 26 September 2022-28 September 2022, pp. 568-571.
- [6] Kumar, Santosh. "A Review on Client-Server Based Applications and Research Opportunity." *International Journal of Scientific Research*, 2019, pp. 33858-33860. doi:10.24327/ijrsr.2019.1007.3768.
- [7] Burbeck, Steve *Applications Programming in Smalltalk-80(TM): How to use Model-View-Controller (MVC)*.
- [8] Chaichenko, S.O., and O.Y. Stupak. "Methodical Recommendations for the Calculation of Individual Rating Indicators." *Slavyansk: DSPU*, 2015.
- [9] Baets, W., Oldenboom, E., Hosken, C. "The Potential of Semantic Analysis for Business (Education)." Available SSRN 3364133, 2019.
- [10] Hutchison, P.D., Daigle, R.J., George, B. "Application of Latent Semantic Analysis in AIS Academic Research.", *Int. J. Account. Inf. Syst.* 31, 2018, pp. 83–96.
- [11] Said A. Salloum, Rehan Khan, Khaled Shaalan. "A Survey of Semantic Analysis Approaches." In: *Proceedings of the International Conference on Artificial Intelligence and Computer Vision (AICV2020)*, 2020, pp. 61–70.